DOCUMENT RESUME

ED 262 774 IR 011 854

TITLE	Satellite-Based Education. A Preliminary Review of the Feasibility of Satellite-Based Educational Communications Technology.
INSTITUTION	New York State Senate, Albany. Senate Education Committee.
PUB DATE	1 Feb 85
NOTE	13p.
PUB TYPE	Information Analyses (070) -- Viewpoints (120)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Communications Satellites; *Distance Education; *Educational Equipment; Elementary Secondary Education; Information Networks; Instructional Innovation; *Instructional Systems; Public Education; State Programs; Statewide Planning
IDENTIFIERS	New York

ABSTRACT

The findings of an investigation by the Educational Committee of the New York State Senate on the advantages of satellite-based educational communications technology are summarized. After a brief foreword by the Chairman, the report is divided into three sections: suggestions for utilizing the technology of satellite-based communications; the need for an impetus for a statewide effort of implementation; and provisions for developing a quality educational communications system. The first section provides an overview of educational technology, suggests possible uses for satellite communications for students and educational personnel, and illustrates how a satellite system functions. The next section lists other states that have adopted satellite technology on a statewide basis; describes the components of an advanced system, and discusses communications systems costs, leasing costs, and other options for communications systems. The third section presents five reasons why New York State should adopt a satellite communications system, describes the noneducational benefits of such systems, and projects three future options, including costs, which are available to the state. Several steps are then recommended for the implementation process, including creation of a commission to review existing technology practices and identifying appropriate software and media programs. In conclusion, brief recommendations are made for developing a strategy for the implementation of an advanced educational communications system. (JB)

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SATELLITE-BASED EDUCATION

A Preliminary Review of the Feasibility of Satellite-Based Educational Communications Technology

New York State Senate Education Committee
Senator James H. Donovan, Chairman

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A Preliminary Review of the
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New York State Senate Education Committee
Senator James H. Donovan, Chairman

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Albany, New York
February 1, 1985

FOREWORD

In 1984, the New York State Senate Education Committee initiated research into the advantages of satellite-based educational communications technology. Its investigation indicated that the use of such advanced technology could benefit school districts and their students as well as State and local governments. The Committee recommended a temporary New York State Commission on Educational Telecommunications Technology Programs.

The Commission would expand upon the Education Committee's work by reviewing the existing state of educational communications technology, examining current instructional and administrative services provided by such technology, identifying what programs could be transmitted via satellite to the State's schools, and funding current research that has the potential to meet the needs of quality instructional materials and programs for schools via telecommunications technology. The Commission would then recommend to the Legislature any economically feasible plan to provide such educational technology services through various federal/state general purpose or authority debt or private business incentive funding mechanisms.

This report summarizes what the Education Committee learned during the course of its research and provides a general indication of the potential for educational telecommunications technology in New York State.

I am sponsoring legislation (Senate Bill # 1781) to carry out the recommendations made on page 9 of this report. Any suggestions or comments on this report or the legislation resulting from it should be forwarded to the Senate Education Committee.

The Committee will co-sponsor a special forum on educational and administrative uses of satellite technology at the Fifth Annual Learning Technology Fair on February 19 and 20 at Albany.

To acquire further testimony on the feasibility of educational satellites, the Senate Education Committee will conduct a hearing on March 6, at 10:00 a.m. in Hearing Room A, Legislative Office Building, Albany.

Senator James H. Donovan
Chairman, Senate Education Committee

UTILIZING THE NEW EDUCATIONAL TECHNOLOGY

Educational technology has made tremendous strides in the past two decades. From the textbook, blackboard, and occasional films and filmstrips that were the mainstays of teaching for years, education has taken a quantum leap into the future with the growing use of computer-assisted instruction and video equipment into the classroom. They are helping each student to proceed at his or her own pace, advancing to new lessons as he or she is able to master the material.

Computer-assisted instruction allows all students to benefit from drill and review without requiring constant teacher intervention. It enables more gifted students to advance at a faster pace than their classmates. Teachers are freed to assist students who have difficulties and to develop new and innovative lessons and materials of their own.

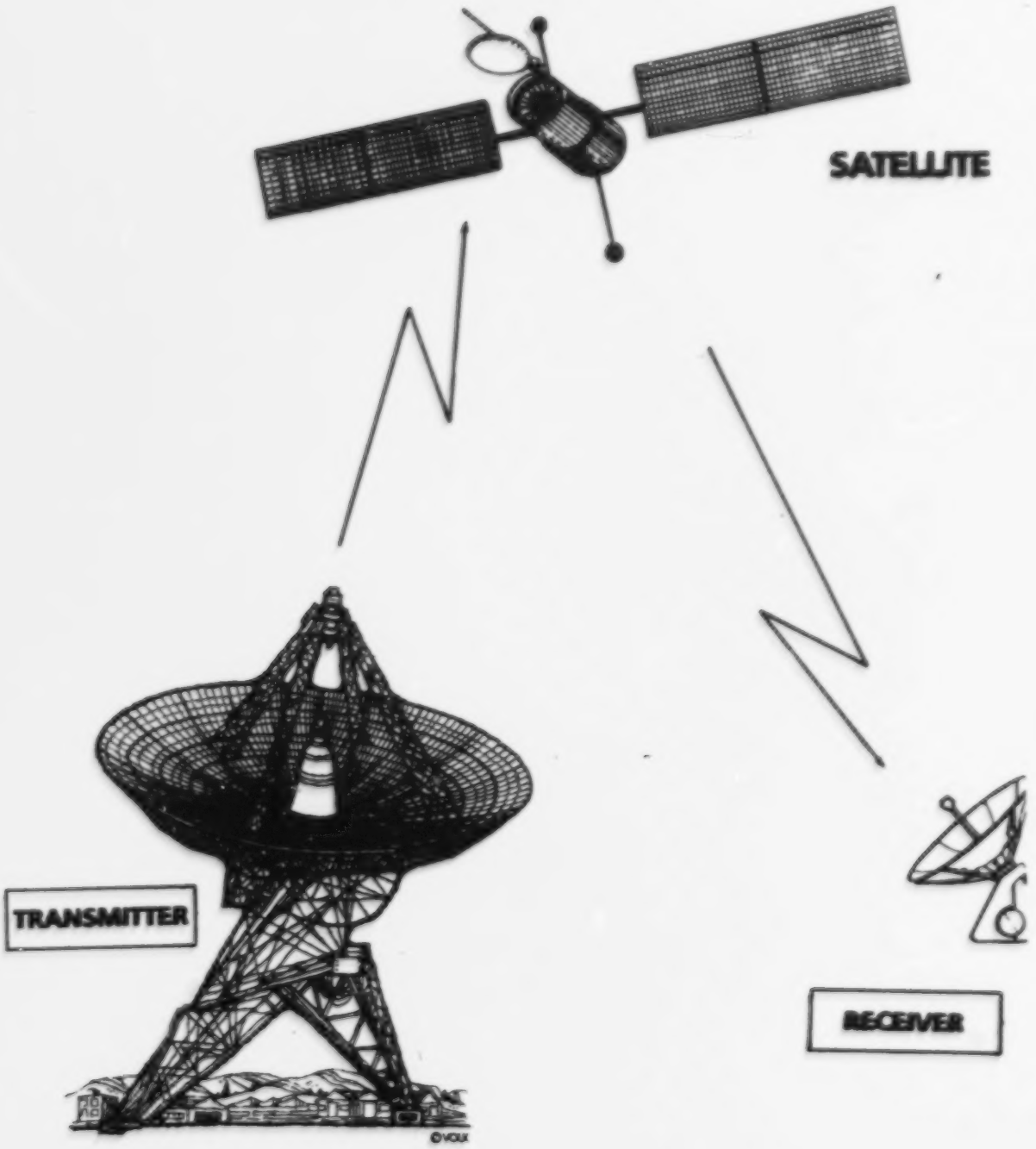
Teachers using video technology may select commercially-developed packages or develop their own programs, either individually, with other faculty members, or with their students. Many schools are now hardwired with cable to take advantage of this technology and some even have inexpensive television studios in which they can produce their own programming. Interactive video, or teleconferencing, can take this concept one step further; special lessons can be broadcast from a central site while classrooms on the receiving end can ask questions by telephone that are then answered on the air. Several commercially-produced instructional programs make use of this concept in which, after initially accessing the central computer by telephone, the student at his or her microcomputer station can participate in the program.

As envisioned in this report, such advanced educational communications technology would not be limited to elementary or secondary schools. Educational personnel could benefit from the training potential of such a system while administrators could gain from its information sharing capabilities. Libraries could be tied into the system to provide research and reference services. The State University of New York's community colleges, four-year campuses, and university centers could be tied in to help fill educational, administrative, and research needs.

Satellite communications would generate their greatest savings in instances in which satellites broadcast to many scattered reception sites, but the network could provide additional savings where hardwire connections were not economically feasible or in which video was required. Holding statewide or regional meetings by teleconferencing would provide another avenue for potential savings; the savings in transportation and housing costs could, in many instances, greatly outweigh the cost of the video and audio hookups in situations where dissemination of information is the primary goal.

As communications technology advances, New York State needs to consider how to best supply it to all students in the state, giving each student an equitable opportunity to benefit from both the best possible instruction and the hardware that is rapidly becoming standard in business and industry. However, it does not come cheaply. Some school districts possess the financial resources to support their pioneering utilization of the new educational technology, but many

do not. The state, with its inherent advantage of economy of scale, can take the lead in introducing the new technology and can, as this exploratory report will outline, provide some services that even the more affluent districts cannot afford.



IMPETUS FOR A STATEWIDE EFFORT

New York State would not be the first state to embark on an effort to harness the new educational and communications technology on a statewide basis. Alaska, has initiated its own program and others are underway in northern California and Illinois. Alaska required an innovative program due to the great distances between its scattered settled areas. Programs in other areas are just coming into their own, as declining costs and improving technology make them possible.

The successful placement of satellites in orbit from the U.S. space shuttle has drawn attention to the growing ease with which satellites may be launched. In November 1984, the space shuttle Discovery retrieved two satellites (Western Union's Westar VI and Indonesia's Palapa B2) and brought them back to earth, where they are being refurbished for resale by the insurance underwriters and for eventual relaunching.

The possibility exists that New York State could purchase one of the satellites recovered by the space shuttle and use it for an advanced communications program. Initial research has been undertaken into what such an effort would cost versus the benefits it would provide.

Recent news articles regarding lower-than-anticipated demand for satellite communications services suggest that leasing costs for satellite transponders will remain relatively reasonable for the next few years. If the demand for this unused capacity remains low, New York State may be able to negotiate very favorable lease rates, thus providing a lower start-up cost or enabling the state to invest more into equipment for schools and other institutions that would be part of its network.

Components of an Advanced System

If New York State either purchased a satellite for launching or leased part of an existing communications satellite, certain equipment, or hardware, would be needed at the outset. The essential component is, of course, a satellite. Such a satellite would have to be in geosynchronous (or geostationary) orbit, which means that its orbit would be fixed over one point on the earth's equator to enable broadcast and receiving equipment to be pointed in a fixed direction to provide for the clearest possible transmission relay and ground reception. All American communications satellites are in such an orbit and are actually spaced across an arc of the sky directly above the equator. Ground stations can focus on the satellite from which they would receive the clearest signal -- namely the one that is highest above the local horizon (the higher above the local horizon a satellite appears, the smaller the antenna dish is that is required to receive an acceptable signal and thus the lower the cost of the purchase or construction of such a dish).

Also essential to any communications system based upon satellite usage are ground stations, also known as downlinks, designed to receive the signals relayed back to earth from the satellite. Without ground stations, there is no

system. They can be relatively simple, consisting of an antenna, signal decoding equipment, and cable that link the ground station to the video, computer, and/or other telecommunications equipment that are used in the system.

A satellite-based communications system requires a source from which information is transmitted. If New York State were to become seriously involved in the forefront of educational technology, it would probably wish to develop many of its own programs even if were going to use any or all of the services available commercially. Depending upon how much the state develops its own materials, the state would need to invest in one or more uplinks, or transmitting stations.

Communications System Costs

A considerable range of system packages could be developed for New York State. New York could follow several routes, depending upon whether it wanted to emphasize decreased satellite costs or decreased downlink costs.

If the State were to utilize a C-band satellite (so designated due to its frequency transmission range), downlinks would require antenna dishes three to five meters in diameter. (Dish size for New York and other Northeastern states is a little larger than for states to the south and west due to the position of the existing satellites above the local horizon.) Downlinks would cost from $5,000 to $10,000 apiece, installed, depending upon the manufacturer, site preparation requirements, and the distance that cable must be run from the downlink to the local video or other equipment designed to use the programming being beamed to the downlink. Although C-band satellites have the advantage of immediate availability, relatively reasonable cost, and proven reliability, their inherent disadvantage lies in the comparatively high cost of their downlink components.

Direct broadcast satellites (DBS), which use transmission components of up to 200 watts power compared with the five to eight watts in C-band orbiters, will require less expensive downlink equipment. One NASA consultant estimated that DBS downlinks will cost only approximately $1,000 -- a savings made possible because the higher DBS broadcasting power will require antenna dishes only one meter in diameter. A satellite communications consultant projected even greater savings if the downlinks were purchased in quantities measured in the hundreds or thousands (there are, for example, approximately 6,000 school buildings in New York State); costs could run as low as $200 to $300 plus approximately $100 apiece for installation. Installed DBS downlinks, if purchased in quantity, would thus cost only a small fraction of what C-band equipment now runs. However, there are no direct broadcast satellites immediately available for New York State use. Implementation of private enterprise plans to launch DBS satellites is presently dependent upon obtaining sufficient financing.

A variation on the DBS option, which broadcasts in the 11.7 to 12.2 GHz compared with the 12.2 to 12.7 GHz for true DBS, could offer nearly comparable savings on downlink costs (though moderately larger, and therefore moderately more expensive, receiving dishes would be needed because the frequency and the satellite wattages are lower). This lower range "DBS" has the advantage of being immediately available, but it has a drawback in that heavy rainstorms can temporarily interfere with signal reception. One test operation noted four losses of

signal due to rainstorm interference over a nine-month span in 1984, with the longest of those lapses being ten minutes.

Uplinks, or ground-to-satellite transmission sites are considerably more expensive than downlinks, as would be expected when one compares the cost of television broadcasting with television reception equipment. Uplinks would cost anywhere from one-half to one million dollars apiece depending upon the sophistication desired and site preparation costs. One experienced telecommunications facilitator from a Midwestern state estimates that an uplink would cost New York $750,000, including the land and necessary engineering study, but not including studio costs. A transportable unit would cost close to the $1 million figure.

New York would also have several options for satellite usage. Purchase cost of a C-band satellite would be in the $25- $35 million range. Launch costs would add another $18- $20 million while operational and service costs would add several million annually. Purchase of one of the recently recovered satellites could possibly save several million dollars versus the purchase price of a new satellite, but launch and operational costs would remain the same according to NASA officials. Satellite communication authorities recommend a two-satellite package, with a back-up satellite in orbit waiting to be activated in the event of uncorrectable problems occurring with the primary satellite. Such a two-satellite package would cost approximately $100- $110 million. A seven-year life span should be anticipated for such a system.

Although a fairly firm purchase price is not readily available for a direct broadcast satellite, it is estimated that their purchase prices will run two to three times higher than that of a C-band satellite once DBS systems come on-line.

Leasing Option

Leasing of a dedicated transponder provides a particularly attractive developmental route from a cost standpoint. A C-band satellite transponder, which is the rebroadcast element in the satellite, could be leased fulltime for approximately $1 million per year. Part-time leasing packages could also be obtained, but savings would result only through limitation of usage to the less desirable hours. Firm leasing figures have not yet been obtained for DBS transponers, but their cost is expected to run several times that of C-band transponders. One transponder would simultaneously handle one video channel and up to several hundred audio or computer channels, the exact number dependent upon the technology used (multiplexing and compression adds greatly to the transmission capability). Leasing a half transponder would provide video capability but would eliminate most simultaneous audio capability.

Downlinks and uplinks should be steerable in the event that New York State might want to change satellites at some future date once it initiated its own satellite system, whether it involved a state-owned satellite or only a leased transponder. Lack of steerability would incur considerable ground costs if a change in satellites were needed or desired. Downlink owners might also wish to consider licensing their sites to protect them from interference, such as from microwave transmission paths that could be installed over unlicensed downlink sites.

Other Options for a Communications System

A satellite-based system is not the only approach New York State could take to develop an advanced communications system for education. Interactive communications have been available for computers over existing telephone transmission lines, but these cannot handle video signals. Coaxial cable could provide the necessary transmission capability, but installation costs to every school building across the state would be prohibitive, even with lease arrangements with existing cable television franchises. Cable for home television costs $6 to $7 per foot installed. If a statewide educational cable network could utilize existing utility poles, the cost of installing just the cable for such a system would run over $34,000 per mile. With a conservative minimum of 10,000 miles of cable needed to interconnect all educational buildings and libraries in the state, upwards of $340 million would be needed to bring the system into full operation. Pole rentals for such a system, at a moderate fee of $5 per pole per month, could run as much as $16 million per year. As will be seen shortly in this report, a system based upon a leased satellite transponder would offer tremendous savings.

Some cost benefit could be obtained over coaxial cable by connecting school districts with microwave transmission facilities. Yet these, too, would be expensive. With tower costs ranging from $100,000 to $150,000 each and a realistic average separation between towers being ten miles, tower construction costs for a system spanning a minimum of 10,000 miles would run approximately $125 million. Further, microwave systems in New York State suffer wintertime damage due to ice build-up. They also pose potential health risks. Though not conclusive, studies have indicated that close proximity to microwave equipment could produce undesirable side effects.

Fiber optics technology, which is still in its developmental stage, promises to offer the transmission capability desired and it could undercut the cost advantages of satellite systems. However, the technology is not readily available for mass installation. It is unlikely that widespread use of fiber optics for long-distance communication will become a reality for another decade. Once it is available, New York could utilize a statewide grid linking schools, libraries, and government facilities. Because optical fiber systems will be able to carry significantly more signal information than would be needed for an educational communications system, the state would probably find it more economical to lease from a commercial system rather than install its own. If New York leased from a commercial optical fiber system as it was installed across the state, it could gradually phase out its leased satellite system, scaling down its transponder use as the optical fiber network assumed more of the communications responsibility. Once it is installed, an optical fiber network will have the advantages of freedom from interference and superior transmission capabilities. But until that technology becomes available on a widespread basis, a satellite-based system appears to offer the best alternative.

DEVELOPING A QUALITY EDUCATIONAL COMMUNICATIONS SYSTEM

There are legitimate reasons for New York State bringing its educational system into the forefront of the communications system. The new technology:

- enables educational systems to provide instruction to each student at a pace that best suits his or her abilities and needs;
- enables teachers to spend additional time assisting students who have difficulties, as well as enriching existing courses of study;
- if state-supported, enables less affluent and smaller districts to take advantage of commercially-developed materials at a much reduced cost;
- gives all students an opportunity to develop familiarity with the technology that is rapidly becoming a standard in business and industry, making the state's students more competitive in future job seeking and making New York a stronger competitor for the new businesses and industries that could strengthen the Empire State's economic revitalization efforts; and
- enables school districts to speed their record keeping and administrative tasks, freeing staff time for program development.

Noneducational Benefits

The communication revolution has not been limited to education alone. There has been a parallel information revolution which has had substantial impact upon libraries across the nation. The state's libraries could be tied into the educational communication network to strengthen their own information resources while assisting school libraries and instructional programs by providing research and program assistance that schools may lack.

In addition, state and local governments could benefit from a statewide satellite communications network. Teleconferencing could cut meeting costs up to half through the elimination of travel in those instances where the basic presentation would not require involved group discussions (it would also still allow for question and answer sessions). Training materials could be disseminated via the network and data could be sent back over the system to central collection and analysis points.

The Future

Based upon cost and availability, a satellite-based system has advantages over any other technology. A switch to a fiber optics network in the future would not make the existing downlink equipment useless as long as television and educational programming from other sources were still carried on satellites.

At this preliminary stage it seems that three options, with varying levels of commitment to a satellite-based system, are essentially available to New York State. The cost estimates are based upon the use of the C-band satellite technology which is presently available.

Option A, which would involve the greatest commitment, would have New York initiate a northeast or eastern seaboard states cooperative to acquire and launch a satellite for education and government. There would be an initial buy-in cost of slightly over $80 million, which could be at least partially offset by leasing unused channel space to private communications operations or perhaps by reducing intra-state long distance telephone communications costs. Bonds with a fixed seven to ten-year payback would be issued by a public authority to initiate the venture. A major uncertainty with this option revolves around the willingness of other states and private enterprise to become involved with the venture. Option A envisions ten to twelve uplinks located in selected metropolitan areas across the state. A minimum of 1,000 downlinks would be included in the package.

Cost Estimate:		
	Satellite Purchase	$30 million
	Launch	20
	Operational Costs (7 years)	14
	Uplinks (10-12)	8
	Downlinks (1,000)	10
	TOTAL	$82 million

Option B would have New York lease a dedicated satellite transponder, providing one video channel and several hundred audio channels for state educational and governmental use. Entering the field on a "test" basis, the option would still envision ten to twelve uplinks strategically sited across the state but would only provide approximately 300 downlinks when fully implemented. The system would have the capacity for utilizing existing commercial educational packages and would, with its strategically located uplink sites, enable school and BOCES districts and state agencies to develop and disseminate programs of their own. This option provides an economy of scale without committing the state to a satellite purchase that would require it to involve other users.

Cost Estimate:		
	Transponder Lease (7 years)	$ 7 million
	Operational Costs (7 years)	7
	Uplinks (10-12)	8
	Downlinks (300)	3
	TOTAL	$25 million

Option C provides a model for a much reduced commitment to satellite-based communications. It would have the state provide a single uplink site in Albany and provide for the purchase of 60 downlinks. Transponder time would be leased on a per hour basis for the limited programming that could be made available. In return for lower start-up costs, the state might consider providing computer terminals and other hardware that downlink users would need.

Cost Estimate:		
	Operational Costs (7 years)	$ 7.0 million
	Uplink (1)	0.8
	Downlinks (60)	0.6
	Computer Terminals (2,000)	2.0
	TOTAL	$10.4 million

Figures in each option are estimates based upon current costs. The numbers of elements in each option are not absolute, but are instead intended to convey reasonable approximations of intensive, moderate, and minimal involvement levels.

System Implementation

Several steps are recommended for the implementation process. First, the New York State Legislature should create a temporary New York State Commission on Educational Telecommunications Technology Programs to consist of fifteen members including four members from the State Senate, four members from the State Assembly, four appointed by the Governor, the Commissioner of Education, the Commissioner of the Office of General Services, and the Chancellor of the State University of New York. The Commission would then build upon the research undertaken by the Senate's Education Committee by:

- reviewing existing educational technology practices and developments in computer and telecommunications information technology;
- examining current instructional and administrative services provided by such technology;
- identifying appropriate educational software and media programs to be transmitted via satellite to schools in New York State;
- funding current research with potential to meet the needs of quality instructional materials and programs for schools via telecommunications technology; and
- recommending, to the Legislature, any economically feasible plan to provide such educational technology services through various federal/state general purpose or authority debt or private business incentive funding mechanisms.

The Commission could also develop the strategy for the implementation of an advanced educational communications system; it might, for example, wish to utilize third-party services to obtain the best possible rates and prices for the equipment it would recommend leasing and/or purchasing. The Commission would possess the expertise to determine the specifics of the best course for New York State to follow in enhancing its educational system through the new communications technology.